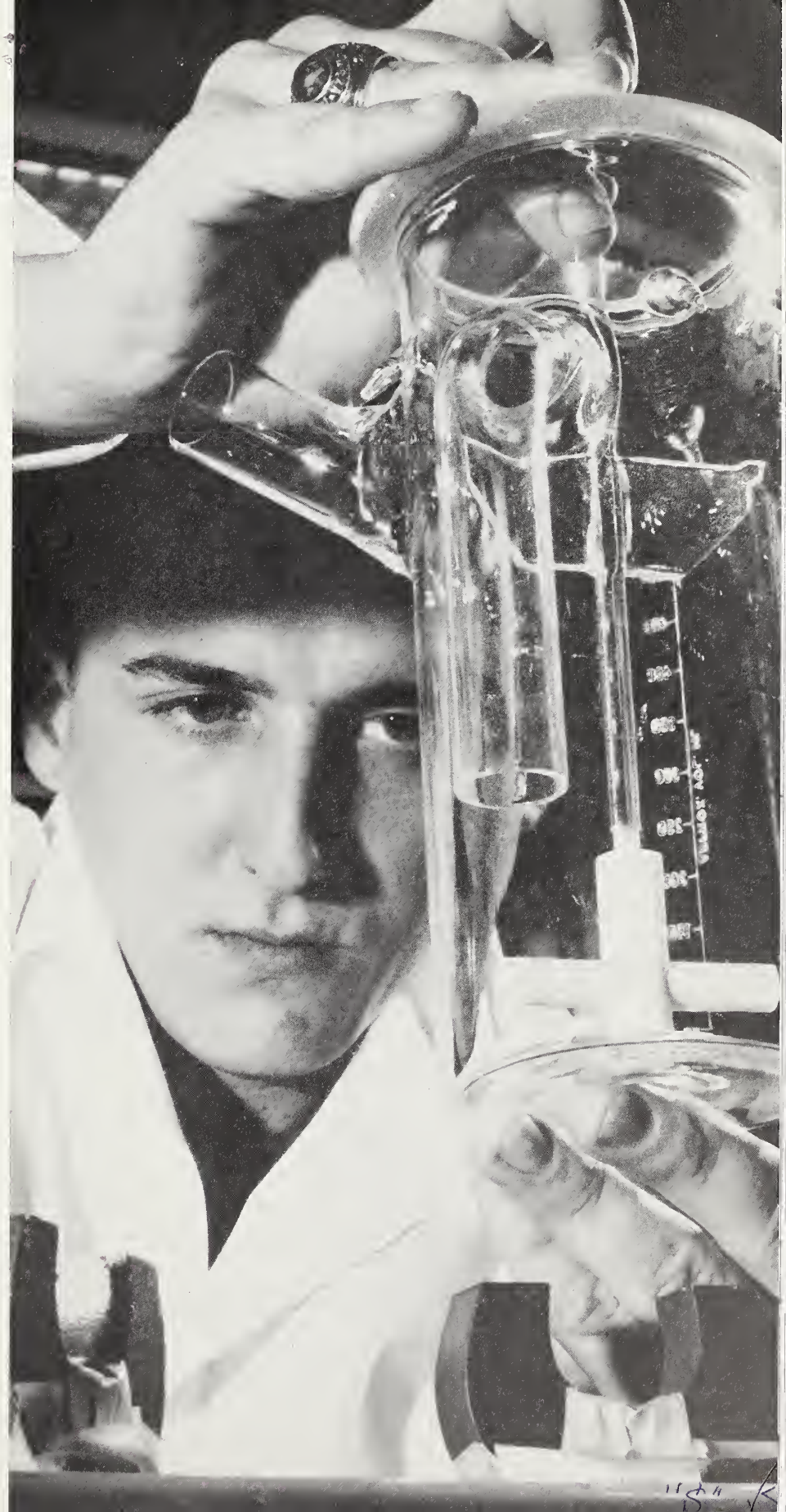
MAY 1966

AGRICULTURAL Research

U.S. DEPARTMENT OF AGRICULTURE



Artificial Rumen Page 8

AGRICULTURAL
Research
May 1966/Vol. 14, No. 11

Food and Freedom

"Agriculture is the key to freedom's victory in Vietnam.

"It now seems possible—through self-help by developing nations—to win the war against world hunger within the next 10 to 20 years."

These recent statements by Secretary Freeman are particularly meaningful to ARS.

Supporting these statements is more than a century of research that has made American agriculture the most productive in the world; an agriculture that today is helping populous India meet a serious food shortage. And this agricultural productivity of ours can be stepped up to meet additional food needs of developing nations in the immediate years ahead.

Perhaps more meaningful is our accumulation of agricultural knowledge, much of it ready to be exported *now* to these countries that are ready to help themselves.

Improved seeds, prescription fertilizers, pesticides—these are most frequently mentioned. An equally important commodity—and also immediately available—are our scientists, themselves.

During the last 6 months of 1965, for example, 51 ARS scientists and technicians were among 174 from the Department helping needy nations increase food production, processing, storage, and distribution. During that same period, 494 foreign trainees were gathering knowledge in the United States in a continuing training program that will help them increase food production in their home countries.

This kind of technical assistance has paid off handsomely in recent years. For example:

- In the Middle East and Africa, modern U.S. pest-control methods practically eliminated heavy outbreaks of locust, thus saving food for millions of people.
- In four West African countries, 11 million cattle have been inoculated against rinderpest.
- In Northern Nigeria, 500,000 acres have been cleared of tsetse flies and opened for beef cattle.
- In India, officials of that country are releasing a new millet that is a cross between a U.S. inbred line and one of their best inbreds. In 2-year tests in India, the new millet yielded 88 percent more grain than the best local varieties.

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Orville L. Freeman, Secretary
U.S. Department of Agriculture

G. W. Irving, Jr., Administrator
Agricultural Research Service

Botanists have found open-air markets, such as this one in Addis Ababa, Ethiopia, an excellent source of spice and medicinal plant samples for the anti-cancer plant screening program. (Photo No. BN–26946)

WORLD PLANT SEARCH

May yield anti-cancer substances, new crops for U.S. farmers

■ ARS botanists are intensively searching the world for plants containing substances that may inhibit cancer.

From their search, supported by funds from the Cancer Chemotherapy National Service Center of the National Cancer Institute, may come new weapons against the disease and new crops for American agriculture.

During the past 5 years, the botanists have collected over 10,000 plant samples, representing about 6,000 of the world's 250,000 species of seed plants.

After long and thorough testing and retesting, extracts from over 400 species, representing 116 plant families, have significantly inhibited tumor activity in laboratory animals.

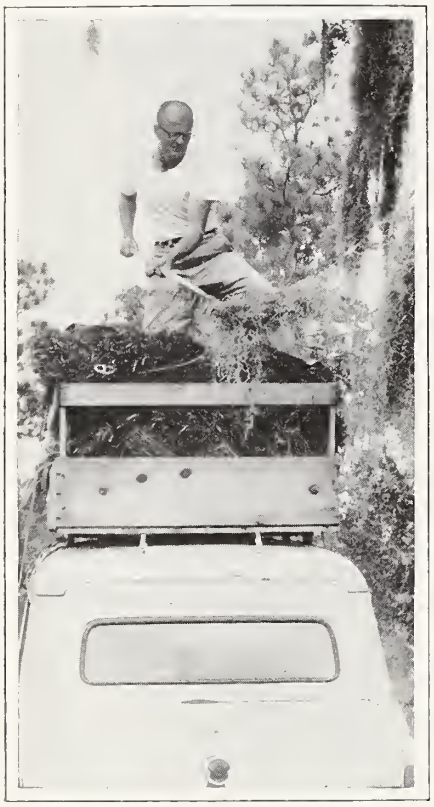
Further research undoubtedly will eliminate many of these species. Some will prove too toxic for safe use; others are certain to be eliminated because of undesirable side effects.

Scientists are encouraged, however, by the fact that plants that have shown antitumor activity to date cover a broad spectrum of the world's plant population. Eventually, they say, substances extracted from some of these plants may be tested on humans.

While chemists will attempt to synthesize promising plant constituents identified by the screening program, plants themselves may have to be relied upon for supplies of compounds too complex for synthesis. Thus, large volumes of plant material may be needed, a development that could lead to new crops to be grown by U.S. farmers.

In the cooperative program, ARS is responsible for collecting and identifying plant samples and for botanical evaluation of test data. Scientists working under National Cancer Institute contracts or grants extract chemical material from plants and subject it to antitumor testing.

Botanist R. E. Perdue, Jr., who heads the Agricultural Research Service collection program, considers every plant structure a candidate as long as it will yield as much as 1 to 2 pounds of dry material for testing. Thus, field botanists collect bulbs, roots, stems, leaves, bark, flowers, and fruit of crops, weeds, forest trees, and other plants. Samples have come from Spain, South Africa, Mexico, Korea, Ethiopia, the U.S., and other countries.



ARS botanist R. E. Perdue, Jr., collects Spanish moss near Jacksonville, Fla., for anti-cancer testing. (Photo No. BN–26947)

When he collects a sample, the field botanist carefully describes the plant and records the date and exact site of the sampling. He also collects a representative part of the plant bearing flowers or fruits to provide a basis for accurate identification.

Each sample is shipped first to the USDA Plant Inspection Station in Washington, D.C., where it is examined for insects or diseases and fumigated to destroy dangerous pests. Then, ARS botanists at Beltsville, Md., confirm the collector's identification.

Next comes laboratory extraction and antitumor testing. Chemists inject the various plant extracts into mice that have experimentally-implanted tumors and then compare tumor development in treated mice with that of untreated control mice.

An extract that significantly reduces tumor growth is subjected to a second, a third, and a fourth test if it continues to demonstrate antitumor activity. If it fails a test, it is eliminated. If it passes the fourth test, it is considered "confirmed active" and becomes a prime subject for intensive research to isolate and identify the chemicals responsible for the antitumor activity.

After a plant extract is designated "confirmed active," field botanists collect 50 pounds or more of the material from the same site, during the same season the original collection was made. By the end of 1965, more than 300 of these "re-collections" had been made.

Chemists test material from a re-collection to see if it has the same antitumor activity as the original. If the test is unsuccessful and a second is also unsuccessful, the re-collection material is abandoned and botanists search for a new supply that will demonstrate the same activity as the original plant sample.

After re-collected material is tested and its antitumor activity reconfirmed, chemists begin a long, step-by-step separation (fractionation) to isolate and identify the active substance in the material.

This, Perdue points out, is a long-term project. Testing initial samples may require a year or two. Re-collections often cannot be scheduled until 3 years after an initial collection. Fractionation alone may take 1 to 2 years or more. Additional time will be needed for preclinical evaluation and clinical trials.☆

Laborers harvest a giant tree lily from a forest in Ethiopia. This is one of the many plants that yield substances for testing in the ARS-National Cancer Institute plant screening program. (Photo No. BN–26940)

UNWILTED LEGUME SILAGE

Good nutrition—
But can it be made more palatable?

■ Recent ARS trials suggest that unwilted legume silage would be a good cattle feed—if a substitute for wilting could be found to make the silage more palatable.

Dairymen know cattle do poorly on unwilted legume silage because they won't eat nearly as much of it as of other feeds. However, if a farmer didn't have to wilt his forage after mowing he'd save time and eliminate the risk of damage from rain.

Dairy cattle nutritionist D. R. Waldo found in tests at Beltsville, Md., that cattle got as much nutrition per pound of dry matter from unwilted silage as they did from field-cured hay. He eliminated through research the possibility that slower passage of feed through the digestive tract causes cattle to eat less unwilted silage. He then concluded that this lower consumption must be because unwilted silage isn't palatable.

But why is it less palatable? Is it because of the formation of amines and aldehydes—chemicals sometimes found as byproducts of unwilted silage—during fermentation in the silo? Research at other stations suggests this possibility, but it hasn't established whether the formation of these chemicals is the only, or even the main reason for the low palatability of unwilted silage.

So far, attempts to prevent these chemical byproducts from forming by mixing additives with silage at the time of ensiling haven't been successful. Scientists think, however, that the use of additives may yield good results eventually. This approach is being followed by ARS and in other research in all major silage producing countries.

Waldo's trials followed work done several years ago by ARS nutritionist J. W. Thomas. Thomas ran tests with unwilted silage and disproved the possibility that its bulk, caused by its high water content, might make it difficult for cattle to consume it in large enough quantities. He soaked hay in water until it was as wet as unwilted silage, then compared the intake of the two feeds. Cattle ate the wet hay more readily than the silage, showing that high water content itself was not responsible for the low intake of the silage.

For his own comparisons, Waldo used two groups of heifers at Beltsville. Heifers in one group were fed good-quality legume forage put into a silo without wilting. Those in the other group received hay cut from the same field. Thus, the nutritionist was able to compare digestion of high-moisture forage to that of forage from which most of the moisture had been removed.

Waldo completely emptied the rumens of heifers fed the two rations and calculated the gross wet and dry weight of the contents. He found the rumen load of silage-fed heifers considerably lighter, showing that they were not overstraining the capacities of their rumens. Other data showed that heifers on silage drank less water, partially compensating for the high water content of their feed.

This finding still left the possibility that digestion of silage is inefficient and that it stays in the rumen longer, slowing the overall progress of feed through the animal. No such slowdown proved to exist. When he measured the flow of feed into the rumen against the level of feed remaining there, Waldo found that silage passed through the rumen as fast as hay, or faster.

Next, he checked the possibility that digestion might be less complete because fermentation in the silo had altered the digestibility of the silage.

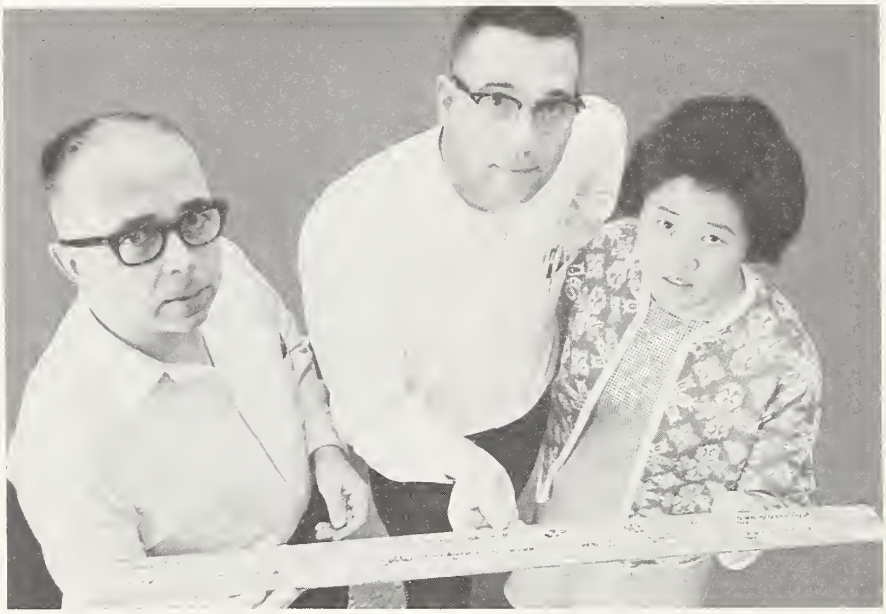
The effect of silo fermentation proved to be measurable, but only for one fiber—hemicellulose. Since hemicellulose forms only a small percentage of legume forage, the net effect on digestibility is small.

Then, Waldo looked beyond the rumen, where the capacity of the digestive tract is much lower. His research showed that heifers on hay passed more feces per day than those on silage, indicating that the digestive tract of silage-fed heifers must be unrestricted—in fact, used below capacity.

Waldo found that energy furnished per pound of dry matter was the same for both forms of feed. Nitrogen derived from silage was slightly less per pound of feed, but enough to support a good growth rate.☆

After 15 months' research . . .

STRUCTURE OF SECOND RNA DETERMINED



Biochemists G. A. Everett and J. T. Madison and project technician Huci-Kuen Kung (left to right) display working model they used in determining structure of tyrosine transfer RNA. (Photo No. PN–1352)

■ ARS biochemists have determined the structure of a second nucleic acid—one of the basic cell components involved in the expression of hereditary characteristics.

It was only last year that the structure of a nucleic acid was first identified (AGR. RES., June 1965, p. 3). Then, a team of ARS-Cornell University scientists announced the structure of alanine transfer RNA (ribonucleic acid) after 7 years of research.

Using techniques they helped develop as members of that team, biochemists J. T. Madison and G. A. Everett, of the U.S. Plant, Soil, and Nutrition Laboratory, Ithaca, N.Y., identified the structure of a second transfer RNA—in less than 15 months. Their work was cooperative with Cornell University Agricultural Experiment Station and the National Science Foundation.

Greater understanding of nucleic acids will probably lead to control of diseases and genetic defects. It is likely that cancer cells grow, for example, as a result of some sort of nucleic acid malfunction, and that virus diseases are transmitted to plants and animals by the nucleic acid of the virus.

Ultimately, many scientists believe, research will permit man to modify the structures of nucleic acids, thus giving him control over the genetic characteristics of all living organisms.

Madison and Everett have structurally identified tyrosine transfer RNA. Transfer RNA's are the smallest of the known biologically active nucleic acids; they can barely be distinguished under an electron microscope.

Nucleic acids are chainlike molecules made up of subunits called nucleotides. The largest nucleic acid, DNA (deoxyribonucleic acid) has thousands of nucleotides, the arrangement of which determines the hereditary blueprint for each individual. In other words, it is this nucleotide arrangement or sequence of DNA molecules that shapes men, animals, and plants into likenesses of their ancestors.

RNA's translate the DNA blueprint into cell-building material by directing the synthesis of thousands of proteins. When enough proteins have been synthesized, the cell enlarges and divides and the organism grows.

Proteins are synthesized from various combinations of 20 amino acids. Some amino acids are derived directly from food taken in by the organism; others are manufactured from food by the organism.

One kind of RNA, called messenger RNA, obtains the blueprint (arrangement of nucleotides) for a specific protein from the cell's DNA. Then a transfer RNA selects one of the 20 amino acids, carries the amino acid to the messenger RNA, and alines with other transfer RNA's. The sequence of this alinement determines the sequence of the amino acids. Therefore, it determines what protein will be synthesized.

The ARS biochemists explain that tyrosine transfer RNA is a chainlike molecule of 78 nucleotides. The nucleotides are organic bases—primarily adenine, guanine, cytosine, and uracil—that are linked together with a sugar substance called ribose-phosphate. The sequence of this linkage determines the structure of the molecule.

As a first step in determining the sequence of nucleotides. Madison and Everett split the molecule with two enzymes and found that fragments from each split were distinctively different. The scientists then deter-

mined the structures of the fragments, and by comparing the fragments from both splits, they were able to determine the sequence of large segments of the molecule.

By manipulating the enzymatic action, Madison and Everett split other tyrosine transfer RNA molecules into fewer and larger pieces than in the first split. When they separated and broke these larger pieces down further, they were able to determine the structure of the entire molecule.

Although the nucleotide sequences of two transfer RNA's have now been determined in the ARS laboratory, the functions of the nucleotides are still largely unknown.

Scientists generally believe that a sequence of three nucleotides in a transfer RNA molecule forms a genetic code word called an anticodon. The anticodon is the crucial part of the transfer RNA that determines where it will aline on the messenger RNA. It forms a temporary bond with a complementary sequence of three nucleotides—called a codon—in the messenger RNA while protein synthesis is taking place.

There is reason to believe, Madison says, that the anticodon in tyrosine transfer RNA is the sequence guanine-pseudouracil-adenine which is approximately in the middle of the chain.☆

TWO MORE RNA's

A German scientist, H. G. Zachau of the University of Cologne, has reported that he has determined the structure of two closely related transfer RNA's—presumably using methods of analysis developed by the original ARS-Cornell University team. Both, Zachau reports, carry the amino acid serine.

Freezing Green Beans

How fast for crisp texture?

■ ARS food scientists at Albany, Calif., have determined how fast green beans must be frozen to preserve their crisp texture during cooking.

E. R. Wolford and M. S. Brown of the Western utilization research laboratory have established a standard that should be the least costly method that freezes the beans at their centers within 6 to 10 minutes. That and all faster rates protect crisp texture during cooking.

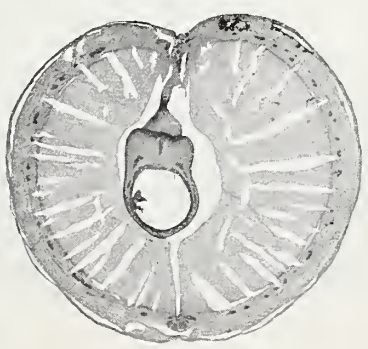
The Albany studies, supported in part by the National Association of Frozen Food Packers, were prompted by the question: Is it necessary to freeze green beans with liquid nitrogen, which boils at about −320 degrees F. and freezes them within 20 seconds or less? Liquid nitrogen is used to some extent to freeze strawberries and other products that tend to become soft when frozen by slower methods. Wolford and Brown's research showed that liquid nitrogen can freeze green beans some 50 times as fast as is necessary to preserve texture.

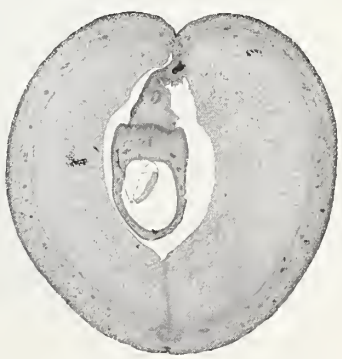
To determine the effect of freezing on texture, the researchers adopted a microscopic technique used by plant physiologists. Samples of beans frozen at various rates are placed for 24 hours in a flask of pure methyl alcohol chilled to 0 degrees F. The flask is then held at room temperature for a full day.

During this period the alcohol dissolves the ice in the bean tissues and the water diffuses into the alcohol. The tissues, broken and unbroken, remain firmly in place and can be sliced thinly with a razor blade for study under a 30-power microscope. Extent of damage is readily appraised and is closely correlated with texture of cooked beans.

The scientists recommend this method to determine proper freezing time for all fruits and vegetables that vary in texture with freezing rate.☆

Microscopic cross-sections of green beans show what happens in freezing by conventional methods compared to freezing within 6 to 10 minutes. The conventionally frozen bean (left) shows cell wall tearing, cell separation, and sloughing off of outer layer. It will lose moisture and become soft when cooked. The quick-frozen bean (right) will retain its texture and flavor when cooked. (Photos Nos. PN–1353 and PN–1354)





ON THE COVER
Technician F. C. Blank demonstrates how an artificial rumen works. A magnet, connected to a motor and pulley, drives the paddle that stirs the feed inside the laboratory rumen. Thus, there's no opening in the bottom of the jar. (Photo No. ST–876–20)

scientists study cattle saliva

Technician Blank "feeds" the artificial rumen. During this process, it is under pressure to keep air from entering. Rumen microbes die when exposed to oxygen. (Photo No. ST–875–10)

WHAT IS ROLE IN DIGESTION?

■ ARS scientists are studying the role saliva plays in beef cattle digestion in separate but supporting studies at Beltsville, Md.

● Animal nutritionists P. A. Putnam and R. R. Oltjen are using beef cattle to help answer the question of how changes in rations affect the ability of an animal to utilize feed.

● Microbiologist L. L. Slyter has aided in designing a simplified artificial rumen, used to study aspects of saliva and digestion that cannot be studied as conveniently in live animals (see accompanying article).

Putnam and Oltjen have found, for example, a marked difference in salivation by steers on different rations. A steer weighing 900 pounds secretes over 50 quarts per day while on Bermudagrass and corn, whereas the same steer produces only about 30 quarts when his ration is changed to alfalfa pellets.

In animals with simple stomachs, the main function of saliva is to aid in swallowing food. It also fulfills this function in cattle, but more important, saliva in cattle neutralizes acids produced by microbes in the rumen. This helps the microbes break down the animal's feed.

Thus, cattle saliva is strongly alkaline, while the saliva produced by animals with simple stomachs is slightly acid.

By measuring saliva flow of steers at various times and under different feeding programs. Putnam and Oltjen have learned that:

● Salivary secretion is continuous, but variable. When cattle don't eat, the flow is about 1 to 2 quarts an hour. During eating the rate of flow triples. and the more an animal eats, the more saliva is secreted. Salivation is lowest during the hour immediately after feeding.

● Individual animals of similar size may have quite different rates of saliva

production.

- The ability of saliva to neutralize acid varies from one test to the next on the same animal. In most of the ARS trials, when saliva volume decreased, its ability to neutralize acid decreased even more.
- Fine grinding or pelleting of feed reduces the flow and effectiveness of saliva. Substituting a purified ration for a normal ration has a similar effect. Purified rations consist of simple food chemicals and are used in research where the precise chemical constituents of feed must be known (AGR. RES., December 1965, p. 10).

How can data on saliva flow be used?

One way, the scientists say, is to better understand what happens when an animal that normally eats mostly forage is switched to a high-grain ration. Cattle feeders have suspected that high-grain rations increase digestive problems, such as bloat.

Scientists have known for some time that an abrupt change from mostly forage to mostly grain alters the proportions among the various types of bacteria in the rumen. One result may be that more acid is produced, and less saliva is present to counteract it. If this happens, rumen acidity may not be properly controlled and digestive trouble could occur.

It is not certain, however, that this trouble actually develops. ARS scientists have fed steers corn alone for 16 weeks with good results. Adding an alkaline mixture to grain rations didn't improve gains and feed conversion. On the contrary, the additives seemed to cause digestive problems not encountered by steers on rations without them.

Oltjen and Putnam will keep looking for a combination of additives that improves grain utilization without undesirable side effects.

The researchers also are approaching the problem from another direction: that of comparing the effects of barley, corn, milo, and wheat on salivary secretion. If different grains have different effects, this might give a clue as to how grain rations affect animal performance.

In other current studies, the ARS scientists are analyzing how salivary flow is affected by such feed constituents as minerals. urea. and vegetable proteins; physical form of a ration; and level of feed consumption.☆

ARTIFICIAL RUMEN AIDS TRIALS

■ The simplified artificial rumen designed in part by microbiologist Slyter is helping ARS scientists study how feed is digested in the rumen.

Some rumen studies, like those being conducted by nutritionists Putnam and Oltjen (see accompanying article), can be carried on with living animals. Other tests wouldn't be as practical, however, without a laboratory tool that simulates most of the processes of an actual rumen.

As a example, Slyter cites a recent investigation that explains what happens when a ruminant's ration is changed from mostly forage to mostly grain. For some time, scientists have known that cattle on high-grain diets don't benefit from additional forage. But they didn't know why.

When Slyter added an acid buffer solution to an artificial rumen stocked with forages, the action of bacteria that digest cellulose dropped sharply. This indicated that excess acid. produced in digestion of high grain rations. kills bacteria cattle need to digest forages.

"Making the rumen of a steer as acid as we made the artificial rumen in this trial," Slyter explains, "would probably cause the steer to go off his feed and ruin the experiment."

The design of the artificial rumen doesn't attempt to follow nature. Instead, it serves the convenience of the operator.

Basically, the artificial rumen is a sealed glass jar stocked with microbes that digest feed. A live steer fills his rumen through a long pipe (the gullet) which also carries saliva from the glands that secrete it. Feed is added to the artificial rumen through a short neck, and saliva flows through a separate port supplied constantly by a proportioning pump.

Muscles in the folds along the bottom and sides of a living rumen stir the mixture of feed and saliva while it ferments. In the artificial rumen, this stirring is done by a motor-driven paddle. Gas produced by fermentation collects in the dome of a natural rumen and is belched out from time to time. In the artificial rumen, by contrast, gas is trapped in a basketball bladder for later chemical analysis.

Slyter began work on the development of an artificial rumen while at the University of Illinois, and continued after he joined ARS. The instrument he aided in developing has attracted international attention for its low construction cost, due mainly to its simple design.

For example, the paddle that stirs the mixture inside the glass jar has no physical connection to the shaft that drives it. Power is transmitted from below the jar by a strong magnet (cover photo) that acts on another magnet on the stem of the paddle inside the jar. This arrangement eliminates the need for an opening through the bottom of the jar, which would then require a special gas-proof seal to keep contents in and contaminants out.

Except for periodic "feeding" and collection of digested material and gases, the artificial rumen can perk along day and night, unattended.☆

Scientists reduce reproduction of cabbage loopers by 90 percent with blacklight lamps and chemosterilant

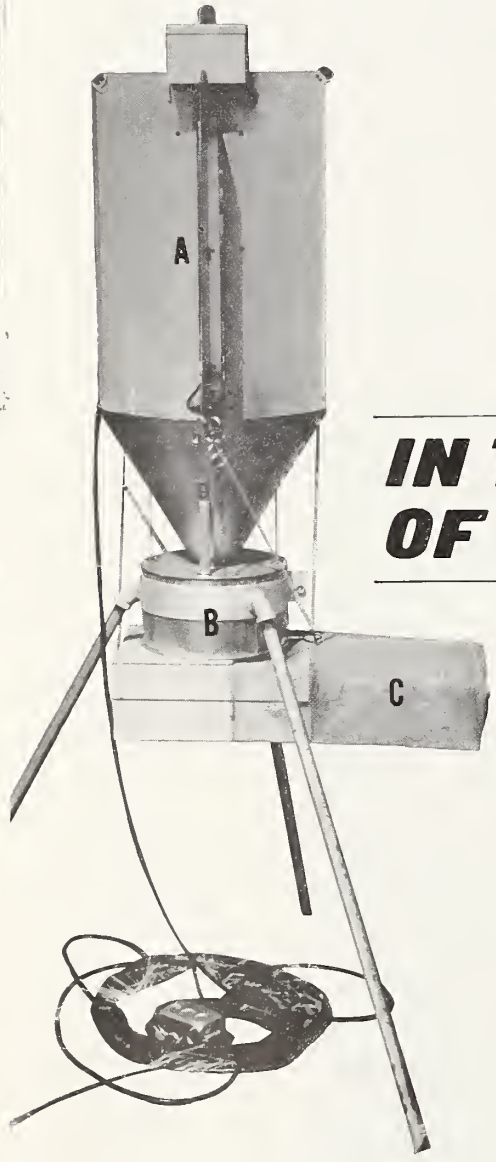
IN THE BLACK OF LIGHT

■ ARS scientists have experimentally reduced cabbage looper reproduction 90 percent by using blacklight lamps in field cages to lure the insects to a chemical that sterilizes the males.

Best known as a pest of cabbage and related crops, the cabbage looper also destroys many other crops including cotton, tobacco, and tomatoes. It is found throughout the United States.

The preliminary field tests were conducted at Riverside, Calif., in screen cages set up in cabbage fields. Results were so encouraging that ARS scientists are considering further field tests, once safe procedures have been developed.

Entomologists T. J. Henneberry and A. F. Howland and agricultural engineer W. W. Wolf conducted the tests, in cooperation with the California Agricultural Experiment Station.



Field traps are now being used in the California studies. Moths are attracted by 15-watt lamp (A), pass through the self-sterilizing unit (B), and are collected in screen cage (C). (Photo No. PN–1355)

Using light to lure insects into contact with a chemosterilant is only one version of the sterility principle of insect control. The great potential of this principle was demonstrated in a campaign in the Southeastern United States 5 years ago, in which screwworms were eradicated. In that campaign, millions of insects were reared, sterilized by exposure to radiation, and released. Sterile released males outnumbered fertile native males by such an overwhelming ratio that reproduction stopped, and the entire population disappeared.

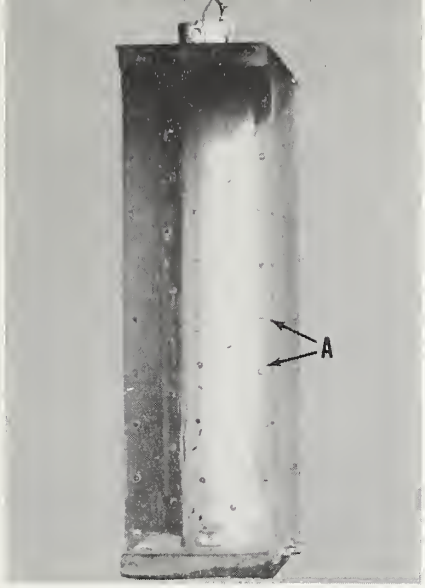
Chemosterilizing insects in the native population is potentially more efficient than the method used to eradicate screwworms. With chemosterilizing, the expensive job of rearing, sterilizing, and distributing the insects is unnecessary.

Lamps used in the California tests lured both male and female cabbage looper adults. At the dosages tested, the chemosterilant sterilized the males and although it was highly effective against the females, it did not sterilize all of them. Ideally, the chemosterilant should sterilize both sexes, the scientists say, but sterilizing only the males can reduce reproduction to a level that would provide effective control—if enough of them are attracted.

ARS scientists previously tested a very promising technique that lured more males than were attracted in the recent California tests (AGR. RES., April 1966, p. 15). They baited lamps with virgin females, which give off a chemical substance that attracts males, and attracted 20 to 30 times as many males as unbaited traps. The increased attractancy resulting from the use of the two lures—light and virgin females—simultaneously is not yet understood and needs further study.

In the recent California tests, scientists used lamps that radiate electromagnetic waves in the near ultraviolet (blacklight) range of the light spectrum, which is invisible to the human eye. These lamps were placed in clear plastic containers and installed in nylon-screen cages (10 feet wide, 24 feet long, and 6 feet high), which were placed over cabbage plants. One blacklight lamp was installed in each of 12 cages.

In 9 of these cages, the clear plastic that covered the blacklight lamp was treated with a mixture containing the chemosterilant tepa. Lamps in the other three cages were



In early trials, blacklight lured moths through openings (A) in plastic covering. (Photo No. PN–1356)

enclosed in untreated plastic.

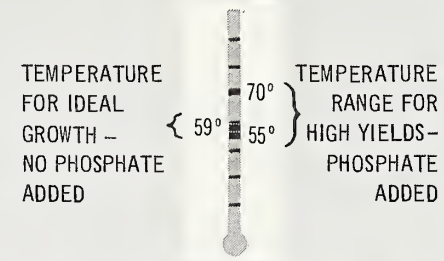
The scientists released 25 male cabbage looper moths into each cage. They then applied three light treatments in the nine cages containing the treated plastic lamp coverings: Lamps were on one night in three cages, two nights in three cages, and three nights in three cages. Lamps in the remaining three cages, those with untreated plastic coverings, were on for all three nights.

Next, the scientists placed 25 unmated females in each cage and allowed them to mate with the males. The scientists waited 14 days for eggs laid by the females to hatch, and counted the larvae.

Larval populations in cages containing the treated lamp covers were only 10 percent of the populations in the cages containing untreated lamp covers. Whether lamps were on one, two, or three nights made no difference in reproduction, indicating that most of the males were sterilized the first night.

The scientists have designed and built an improved version of the attractant-chemosterilization device for forthcoming field tests.☆

PHOSPHORUS counteracts high, low soil temperatures



■ Grain producers in the Great Plains may soon be able to prevent one form of crop stunting, that caused by high or low soil temperature in the face of a phosphorus deficiency.

ARS soil scientist J. F. Power of the Northern Great Plains Research Center found, in tests at Mandan, N. Dak., that barley growth is inhibited significantly when available phosphorus is at a low level and soil temperature varies only a few degrees from 59 degrees F.

In most of the grain growing areas of the Great Plains, the temperature of the soil at plow depth is normally between 50 and 75 degrees F. from the time plants begin to enlarge until grain is nearly mature.

Power grew barley in Parshall fine silt loam at six different soil temperatures, ranging from 45 to 80 degrees F. He grew half the plants in soil with 7.6 parts per million of available phosphorus; the other half, in soil with 3.8 p.p.m. of available phosphorus. Of the plants grown on each soil, some received no fertilizer. Others received superphosphate at rates equivalent to either 80 or 160 pounds per acre.

Plants on soil low in available phosphorus, with no additional fertilizer, grew poorly at all soil temperatures. On soil high in available phosphorus, with no additional fertilizer, plants grew well when soil temperature was at the optimum 59 degrees. On soil high in available phosphorus, with additional superphosphate added, plants grew well over a wide range of soil temperatures.

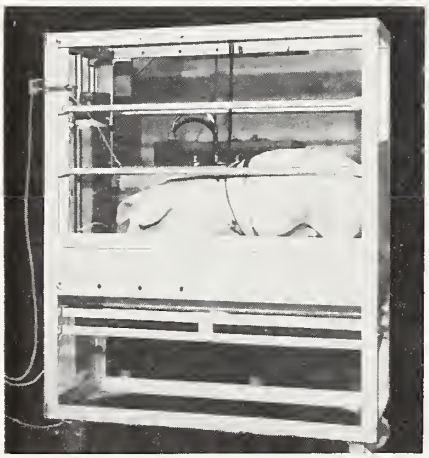
As might be expected, barley made its top yield under the best conditions: Soil high in available phosphorus, fertilized with 160 pounds of superphosphate per acre, and maintained at a temperature of 59 degrees.

These combinations of available soil phosphorus, added superphosphate, and soil temperature produced yields of at least 80 percent of the maximum:

- Low available phosphorus; 80 pounds superphosphate per acre; soil temperature between 55 and 61 degrees F.
- Low available phosphorus; 160 pounds superphosphate per acre; soil temperature between 51 and 69 degrees F.
- High available phosphorus; 80 pounds superphosphate per acre; soil temperature between 56 and 71 degrees F.
- High available phosphorus; 160 pounds superphosphate per acre; soil temperature between 51 and 74 degrees F.☆

HOW DO DISEASES KILL?

Basic research with hogs may disclose answers



Electronic recording device, monitored by H. M. Cook, is used to record measurements of blood pressure, heart and respiratory rate, and temperature of diseased hog. Cables run from recording machine to infected hog, located in a separate room. (Photos Nos. PN–1357 and PN–1358)

■ A team of ARS scientists is studying hogs diseased with erysipelas as part of long-term basic research to answer the question: How do diseases kill?

Knowledge gained from this and related studies ultimately will help veterinary scientists who are seeking the best possible means to control diseases that kill or cripple millions of animals each year.

The scientists, highly skilled in various disciplines, chose erysipelas for their tests at the National Animal Disease Laboratory, Ames, Iowa, because of its widespread effects on animals and because it is found in most parts of the world. The disease is caused by the bacterium *Erysipelothrix rhusiopathiae,* which attacks, besides hogs, sheep, turkeys, chickens, ducks, pheasants, pigeons, parrots, quail, and a variety of small wild birds.

From previous studies, headed by R. W. Dougherty and R. D. Shuman of ARS, the Ames scientists knew that significant changes occur in the blood of hogs with erysipelas. They knew also that starvation causes similar changes. Therefore, D. A. Witzel, R. L. Wood, and W. B. Buck investigated the extent lack of appetite, which accompanies erysipelas, contributes to changes in the blood of sick hogs.

The scientists denied feed to a group of test hogs and then measured the levels of plasma glucose and of a serum enzyme, SGO–T. Within 18 hours after feed was denied, the two blood constituents had decreased an average of 11 and 14 percent. And only 2 hours after the test hogs were fed. the levels of plasma glucose and SGO–T had returned to normal.

In hogs infested with erysipelas, the scientists found that glucose levels decreased 40 to 60 percent, whereas SGO–T increased 267 to 700 percent. When feed intake of healthy hogs was reduced to a level equal to that of the infected hogs, the level of glucose and SGO–T decreased 13 and 29 percent, respectively.

The scientists conclude from these results that blood glucose levels may contribute to death. Although an increase in SGO–T activity is generally considered to be an indication of tissue damage, they feel that levels in this experiment probably weren't high enough to be a significant factor in the cause of death. The lack of appetite in sick hogs, therefore, does not appear to be an important contributor to the death of erysipelas-infected hogs.

The Ames research team used 17 female hogs in the experiments, each weighing 75 to 100 pounds. Six were farrowed naturally and 11 were obtained by hysterectomy. All were raised in a disease-free environment for about 4 months without any vaccines, antiserums, or antibiotics.

To obtain blood for analysis, they inserted a plastic tube in a femoral artery of each hog, performing this surgery at least 2 weeks before the tests. This allowed the hogs time to recover fully. By implanting the tubes permanently, the scientists then could extract tiny quantities of blood three times a day to make tests of the effect of erysipelas on blood.☆

TREATED CLOTH CONTROLS WEEDS

■ Loosely woven cloth treated with a weedkiller may prove to be the safest and most convenient way to apply herbicides to small garden plots, and may also prove valuable for use in greenhouses and by commercial vegetable growers and nurserymen.

Developed by ARS plant physiologist L. L. Danielson at Beltsville, Md., this method of herbicide application is much simpler than the usual spray method. To control weeds, you merely cover the area to be treated with the herbicidal cloth.

Although the cloth is not on the market, manufacturers are interested and are awaiting further tests on its effectiveness, economy, and safety for general use. Prospects look good.

Danielson's field and greenhouse studies have shown that the cloth works with 14 different herbicides—indicating that it will be possible to treat the cloth with specific herbicides at proper rates for specific purposes.

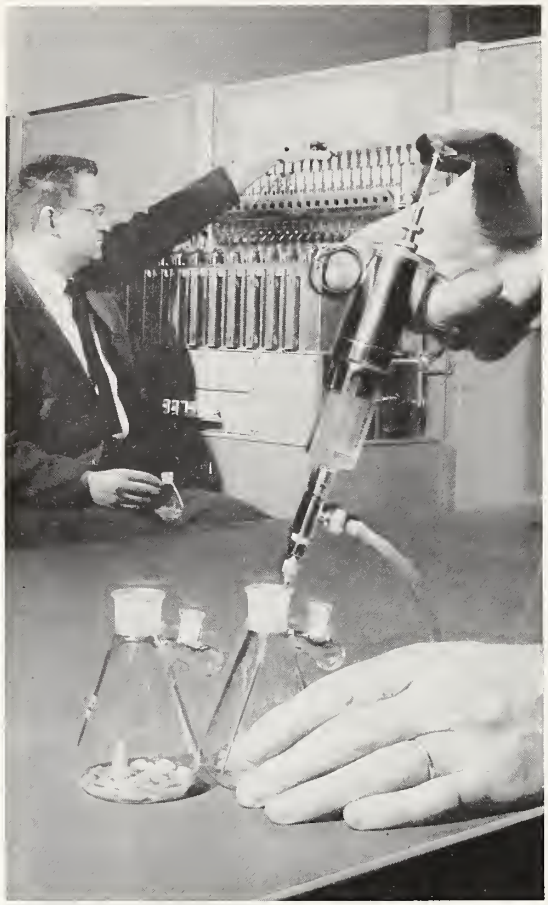
Thus, the treated cloth can eliminate the danger of applying too much or too little of an herbicide. Also eliminated—the danger of accidental poisoning that exists with herbicides in conventional liquid form, and the problem of spray drift which can damage nearby flowers, trees, and shrubs.

For successful weed control, the herbicide-treated cloth is cut to fit the area to be treated, then put in place. The edges are anchored, or the cloth is covered entirely with a thin layer of soil. Since the cloth decomposes before the end of the growing season, it does not interfere with tillage in succeeding cropping seasons.☆

Treated cloth, placed around a plant, is covered lightly with soil. Cloth on a roll, displayed by technician G. H. Richardson, is impregnated with herbicide in container below roll. (Photos Nos. ST 884–3 and ST 884–18)

new test for vigor

Shows growth potential of seeds



In seed vigor test developed by plant physiologist Woodstock, water is added to seeds in flasks to speed up rate of respiration so it can be measured on respirometer (in background). (Photo No. PN–1359)

■ When a farmer or gardener buys seed, the analysis on the label assures him that the seed is alive and will germinate.

At present, however, he has no assurance that seedlings will develop into strong, healthy plants. A new seed vigor test being developed by ARS plant physiologist L. W. Woodstock at Beltsville, Md., could give farmers and gardeners that assurance.

The test shows whether or not seeds have the vigor to survive the period before plant roots become established in the soil. During that time, the seedling must reach the soil surface and begin manufacturing its own food through photosynthesis—before its stored energy is used up. It's one of the most hazardous periods in the life of a plant, particularly because the seedling is then highly susceptible to soil-borne disease organisms.

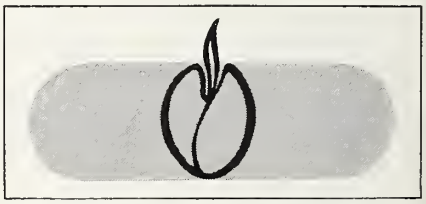
Limited so far to corn and lima beans, the seed vigor test has screened out seeds injured by heat, freezing, and adverse long-term storage conditions. Seeds injured by these causes—even those with mild injury—were revealed by the vigor test and were slow to emerge from the soil in field plots.

Standard germination tests did not always distinguish between mildly injured and healthy seeds.

The new test is faster than other laboratory methods for determining seedling vigor. Cold tests for corn, for example, take as long as 14 days, and they require infected soil, which is hard to standardize. Woodstock's test will handle samples of from 20 to 1,000 seeds, depending on seed size, in as little as 2 to 3 hours.

Despite their inanimate appearance, germinating seeds respire as do other living things. Woodstock uses a respirometer, a standard laboratory device, to measure the rate at which seeds take in minute amounts of oxygen and give off carbon dioxide.

By correlating respirometer tests with field trials, Woodstock has determined that germinating seeds which respire faster are more vigorous. They sprout and grow faster in the crucial period of 3 to 9 days after planting. And this early growth rate is closely related to growth rates 2 to 3 weeks later.



The respirometer used in the ARS studies is available commercially; however, it is more sophisticated than necessary. A simple but effective respirometer could be assembled for as little as $25 to $50, using an airtight flask, a U-shaped tube, and a water bath. Models most useful to seed laboratories might cost $300 to $500.

Woodstock is conducting additional trials to find out if field stands grown from tested seeds confirm the encouraging results he has obtained so far. He plans further experiments with a larger variety of crop and vegetable seeds under a wider range of conditions affecting seed vigor.☆

SPRAYS MAY BE APPLIED MORE ACCURATELY

When particles are electrically charged

■ Experimental equipment that applies an electrical charge to spray particles may lead to more precise use of insecticides as aerial sprays.

For farmers and commercial operators, it would have the advantages of directing insecticides to plants where they are needed, minimizing waste, and reducing the danger of drift of spray material to neighboring fields or other areas.

Agricultural engineers J. B. Carlton and D. A. Isler (now retired) developed the device, called an electrostatic spinner. It is based on the principle that the earth and growing plants are electrically charged. In fair weather, this charge is negative.

Thus, positively charged spray particles are attracted to all surfaces of negatively charged plants. Although the earth also carries a negative charge, spray particles applied from the air are attracted to plants before they reach the earth.

This principle is used in electrostatic ground dusters which are now commercially available. However, the work by Carlton and Isler is the first attempt to use the principle for aerial spraying.

In preliminary laboratory and field tests at Beltsville, Md., Carlton and Isler used water, rather than an insecticide. Results to date indicate that charging spray particles will: (1) increase the amount of spray deposited on both top and bottom leaf surfaces; (2) produce a more uniform drop size; and (3) decrease the amount of spray that falls to the ground—where it does no good.

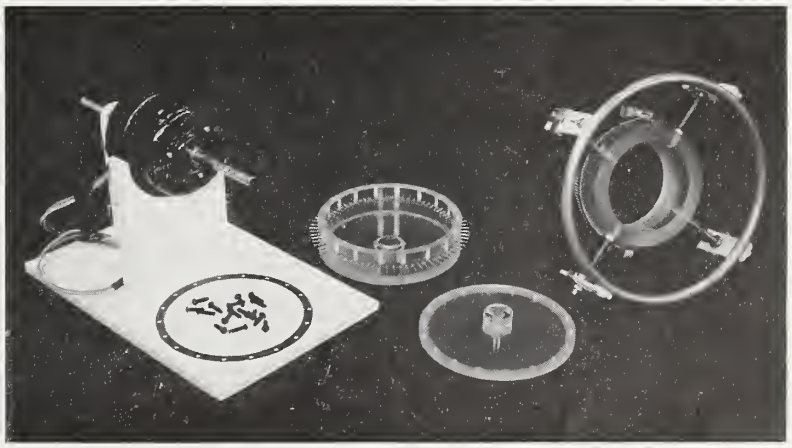
The electrostatic spinner will be field-tested this year with insecticides. Additional tests will be conducted to get more basic information on the effects of the charged liquid spray particles on foliage.

The experimental device consists of three basic parts:

- A 12-volt, direct-current motor. The motor shaft is a hollow tube that serves as the spray channel.
- The spinner, which is an inch-long cylinder cut from a plexiglass tube 4¾ inches in diameter. The cylinder has 72 outlets, called capillaries, cut from stainless steel tubing and inserted through holes drilled in the plexiglass. The capillaries are about 0.022-inch in diameter, and extend outward about one-fourth inch from the surface of the cylinder.
- A hollow ring (torus) made of copper tubing. The ring, mounted slightly ahead of the spinner, can be energized with high direct-current voltage, which charges the spray particles as they leave the spinner.

Carlton and Isler also designed and built a ground instrument to monitor the charge on the particles.☆

The electrostatic spinner is mounted on the wing of aircraft used for experimental spraying. The spinner has a rate of flow of 1¼ gallons per minute at a pressure of 15 pounds per square inch. Total cost of parts in the electrostatic spinner was about $10. (Photos Nos. PN–1360 and PN–1361)



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AGRISEARCH NOTES

Scabies mites infest rabbit

Some individual animals that usually are not susceptible to mites that cause sheep scabies can become infested, thereby providing hiding places and sources of future infestations by this pest.

Parasitic mites collected from a steer were introduced experimentally into the ear of a rabbit. They became established and killed the rabbit. Although mites were transferred successfully to a sheep from the rabbit before its death, attempts to infest cattle and a second rabbit failed.

Regulatory officials know that scabies, the subject of an intensive Federal-State eradication campaign, can be very elusive. There have been instances during the past few years when entire States have been freed of this parasite and then new infestations arose from unknown sources.

In research reported by ARS parasitologist W. P. Meleney, skin scrapings taken from a steer in Colorado

were received by ARS at Albuquerque, N. Mex., for determination of the cause of lesions found on the steer. Microscopic examination of the scrapings revealed *Psoroptes ovis*, the scab mite of sheep and cattle.

On examining the inside of the tin mailing container that contained the scrapings, Meleney found it swarming with mites. These were collected on absorbent cotton, which was packed gently into the lower portions of the ear of a white, New Zealand rabbit and fastened in place.

One week later, when the cotton was removed, two small lesions had developed, and live mites were found. Three months and a week after the mites had been placed in its ear, the rabbit was found dead.

While the infestation had been building up to lethal proportions on the rabbit, scab material was harvested periodically and transferred to 4 cows, a sheep, and the ears of a black rabbit of unknown breeding. The cows and the black rabbit developed only temporary lesions, but the sheep developed typical sheep scab.

New pioneering laboratory

The role of internal parasites as carriers of animal diseases will be studied at a new ARS Pioneering Research Laboratory on Endoparasites as Vectors and Reservoirs of Disease.

Scientists at this laboratory, on the campus of Washington State University at Pullman, will explore the part played by worms, flukes, and other parasites in transmitting viruses, rickettsiae, and bacteria.

Internal parasites, present in great numbers throughout the animal kingdom, are able to live and reproduce within their hosts. In this protected environment, disease agents in these parasites would be much more persistent than those borne by insects—if the agent were able to conform to the life cycle of a parasite, propagate within it, rest when it rests, and be released to infect the host when the host is attacked by the parasite.

In support of the parasite-carrier theory, a parasitic fluke was found in past research to harbor the microorganisms that cause salmon "poisoning" disease and Elokomin fluke fever. Because of the complex life cycle of this fluke—animal to snail to fish to animal—it is not likely that these diseases are spread by any other carrier. (AGR. RES., March 1964, p. 12, and April 1966, p. 16).

Many such parasitic carriers will be studied at the laboratory, headed by research veterinarian J. R. Gorham and staffed by veterinarian R. K. Farrell, microbiologist K. W. Hagan, and research and graduate assistants.

The Pullman laboratory will be the 25th pioneering research laboratory established by USDA since 1957 to unearth facts from beyond the limits of present-day knowledge. Each laboratory does basic research in a specific problem area.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

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